

Collection

“ Les savoirs partagés® ”

Bird flu **AVIAN** influenza

2006

The H5N1 virus,
poultry,
other animals,
and people here
and elsewhere,
from Asia
to Africa.





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Bird flu

AVIAN

influenza

from Asia to Africa.



Examination of a Hottentot teal hunted in Niger, 2006 - Alexandre Caron, © Cirad

- an animal health problem in countries of the South
- a H5N1 virus with pathogenic strains
- birds that die
- other animal species concerned or infected
- healthy carriers
- a proven risk for man
- reasons for fear, others for hope
- a risk to be managed within the context of the globalization of trade in animals and animal products
- problems and remedies to be increasingly shared
- scientific knowledge adapted to diverse audiences.

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Foreword

Above all else, bird flu, better named avian influenza, is an animal health problem. The current episode originated in Southeast Asia at least as far back as 1997. Its rapid spread to Central Asia, Europe, the Middle East, and Africa in 2005 and 2006 caused legitimate concern throughout the entire world.

Once again, the most socially, economically, and educationally disadvantaged populations are most exposed to this epidemic, as much to its costs (mortality and the culling of poultry) as to the health risks involved. To better share knowledge with a broad spectrum of socio-economic classes and age groups, researchers in the Animal Production and Veterinary Medicine Department of CIRAD worked with colleagues in the North and South to create this educational handbook, imagined, constructed, and validated through their scientific knowledge.

A handwritten signature in blue ink, appearing to read "E. Camus", is shown above a horizontal line.

Emmanuel CAMUS
Director, EMVT Department, CIRAD

Partner institutions

The **World Organization for Animal Health (OIE)**, created in 1924, is one of the world's oldest intergovernmental organizations and also, with 167 member countries, one of the most representative. Present on 5 continents through regional coordinators and a network of collaborating centers and reference laboratories, the OIE manages a global surveillance and early-warning system for animal health and plays a key role in the field of scientific research and information. OIE also defines health standards for global trade in animals and animal products. In this respect, it is a major actor in political and financial mechanisms of international cooperation for less advanced and developing countries.

The **Food and Agriculture Organization of the United Nations (FAO)** plays a leading role in international efforts against famine. At the service of developed and developing countries, it is a neutral tribunal within which all countries may meet on an equal footing to negotiate agreements and debate policy. It also is a source of knowledge and information and works to assist developing countries and countries in transition to modernize and improve agricultural, forestry, and fishery practices and to guarantee good nutrition for all. Since its creation in 1945, it has consecrated particular attention to the development of rural zones where 70% of the world's poor and hungry live. Its four main fields of activity consist of making information available to all, sharing policy expertise, serving as a meeting place for governments, and the transfer of knowledge to the field.

The **Inter-African Bureau of Animal Resources of the African Union (AU-IBAR)** is a bureau of the Department of Rural Economics and Agriculture of the African Union. Its current mandate is to control major trans-border diseases, improve genetic and food resources, develop information, communication and technologies dedicated to animal production, and reinforce the trade in animals and animal products through an improvement of quality insurance and the harmonization of policies and norms related to this trade.

The **Technical Centre for Agricultural and Rural Cooperation (CTA) ACP-EU** was created in 1983 within the framework of the Lomé Convention between governments in the ACP Group (African, Caribbean and Pacific group of states) and member countries of the European Union. Since 2000, the TCA operates within the context of the Cotonou ACP-CE agreement. The TCA's mission is to develop and provide services that improve access of ACP countries to information on agricultural and rural development and to reinforce the capacity of these countries to produce, acquire, exchange, and exploit information in this field.

The **French Ministry of Foreign Affairs (MFA)**, in pursuing sectorial policies and the Millennium objectives for development, aims to promote the emergence of societies able to access production processes and the diffusion of knowledge and culture. In this regard, it provides its partners support for sustainable development, particularly in the field of research and the promotion of access to culture and knowledge.

The **National Institute for Agriculture Research (INRA)**, founded in 1946, is a mission-oriented public research institution working in the field of agriculture, food, nutrition and food safety, environment and land management, with particular emphasis on sustainable development. Its human resources are 1840 researchers, 2360 engineers, 4640 technicians and administrative staff, 1200 doctoral students and 1000 foreign trainees and researchers. It is organized in 14 scientific departments and 21 regional centers. Its budget in 2005 was € 680 million.

Its principal goals are :

- * to produce and disseminate scientific knowledge
- * to develop innovations and know-how for the benefit of society
- * to bring expertise for decision-making by public and private sector players
- * to promote scientific culture and participate in the science / society debate
- * to train in and through research.

INRA is involved in a large number of partnerships and exchanges with the international scientific community in Europe, America, Asia and Africa.

Agropolis International was established in 1986 at the initiative of 17 research and higher education institutions with the support of the Ministries of Research, Agriculture, and Cooperation. It now consists of 9 research organizations (BRGM, Cemagref, CEA, Cirad, CNRS, Ifremer, Inra, Inserm, IRD), 14 research and training institutions (AGRO.M, CEP de Florac, CIHEAM, IAM.M, CNEARC, ENGREF, ENSIA, SIARC, ESCAIA, ICRA, ISTOM, UM I, UM II, UM III, UP Via Dominitia, SUP de CO), 1 coordinating group, 19 associated members and 3 local administrative divisions.

The **Aviculture Technical Institute (ITAVI)** is a professional organization specialized in the development of, and applied research in, poultry farming, rabbit production, and goose and duck production. It provides technical and financial support to poultry farmers and to the overall sector. Every year, ITAVI organizes a training program designed for actors in the aviculture sector in tropical zones; it also has published two guides focused on bird farming in hot climates to address the specific needs of these professionals.

CEVA SANTE ANIMALE is a French veterinary pharmaceutical company with an international reach. Exclusively dedicated to animal health, the CEVA SANTE ANIMALE group conceives, develops, registers, produces, and markets veterinary medicines (antibiotics, control of reproduction, vaccines, metabolic correctors, nervous system medicines, anti-parasites). Due to its presence in zones infected with avian influenza, the CEVA SANTE ANIMALE group has been actively engaged in official avian influenza vaccination programs since the beginning of the epizootic in Asia. Its long partnership with CIRAD testifies to its engagement.

The **French Agricultural Research Centre for International Development (CIRAD)** focuses on research, experimentation, training operations, information programs, and innovation. Its strengths in life, social, and engineering sciences are applied to food and agriculture and to the management of natural resources and social issues. One of the missions of the Livestock Production and Veterinary Medicine department is to capitalize on and expand current understanding of avian influenza. Within the Innovation and Communication department, the Innovative Education unit aims to bring educational value to scientific, technical, and practical knowledge through novel means.



A Wetlands International agent records data on avian influenza from wild birds sold in the Mopti market in Mali, 2006 – Alexandre Caron, © Cirad



Preface

Recently, highly pathogenic avian influenza (HPAI) has experienced a spectacular expansion in numerous countries.

Originating in Southeast Asia, it has arrived in Africa after crossing several European countries.



Its economic consequences, already serious in developed countries, are dramatic for developing ones.

They are amplified by poor knowledge about the disease, particularly a lack of reliable consumer information.

It therefore is important that this educational handbook, which is destined for a wide audience, explains in clear terms, using numerous illustrations, what HPAI really is.

I salute this initiative, and I hope that the greatest number of people in our member countries may have access to it.



Bernard VALLAT
Director general
World Organization for Animal Health (OIE)



Roadside sale of laying hens in Madagascar, 2006 – Renaud Lancelot, © Cirad

Preface

Despite international efforts, avian influenza continues to spread throughout the world: in 2006, several African countries were affected one after another.

The propagation of the virus in Africa, which lies at the heart of our Priority Solidarity Zone (PSZ), requires new means to assist our partner countries in addressing the epizootic. Beyond a moral duty to come to the assistance of the most vulnerable, aiding these countries is in our own interest because avian influenza illustrates the interdependence of the world today: if the virus is not concretely controlled in developing countries, it will continue to propagate beyond administrative borders.

The control of health crises are therefore everyone's business – governments, international organizations, and citizens. It is essential to detect suspect cases as quickly as possible and to take the necessary measures to treat them, but also to avoid risky behavior and disproportionate responses that only amplify health and economic damage. For these reasons, it is important to develop effective and appropriate forms of communication, using clear language, to respond to people's legitimate concerns.

This need for information is particularly strong in the case of avian influenza, an animal disease that has infected livestock on three continents. It must be emphasized that the people infected to date were poultry farmers or members of their families who probably were poorly informed about the disease, the behaviors to avoid, and the precautions to take during their daily contact with poultry.

The educational handbook prepared by CIRAD is an attempt to respond to this need for information. It is addressed to all actors in the field as well as to various opinion relay points in France's Priority Solidarity Zone. It is necessary to consolidate in a practical format the main points of our current understanding of this virus whose animal source must be controlled and the transmission between people monitored. I have no doubt that this document, a veritable vademecum on avian influenza, will contribute to mobilization at the field level, which France encouraged and for which it will continue to resolutely act.



A handwritten signature in black ink, which appears to read 'Brigitte Girardin'.

Brigitte GIRARDIN

Minister delegate for Cooperation,
Development and the French Speaking World

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Poultry production in countries in the South

Varied farm situations

In Southeast Asia, half of the poultry population is raised intensively on medium to large scale commercial farms. The other half is a source of income for small farmers who keep only a few dozen ducks, chickens, geese, or turkeys. The birds live together in close proximity to the farmer's family, especially the children, who take care of and play with them. At certain times of day and during certain periods of the year, poultry and humans share the same habitat.



Broiler farm on raised piles in Vietnam, 2002 – Vincent Porphyre, © Cirad

In Africa, intensive poultry farming (or aviculture) has been developed in North Africa (from Morocco to Egypt), South Africa, and around the large cities of the Gulf of Guinea (Lagos, Abidjan, ...) and East Africa (Addis Ababa, Nairobi, ...). Elsewhere, backyard-bird farming dominates, with similar promiscuity between people and poultry found in Southeast Asia.

In Madagascar, the situation closely resembles Asia: large areas are covered by rice fields with numerous geese and duck farms in close contact with pigs and people.

Virus markets

Live-bird markets are a prime location for the transmission and spread of viruses. Contaminated animals that do not present an obvious sign of disease may be bought and transported to a new environment that is conducive to the spread of the virus. In addition, small-scale farmers and merchants often come in close contact with the poultry while transporting them by hand, bicycle, cycle rickshaw, in public transportation, or in the market stalls.



Poultry cages at the Mopti market in Mali, 2006 – Alexandre Caron, © Cirad

The return of unsold goods

Healthy birds may be contaminated in the market by other diseased poultry and if they are not sold then spread the virus upon their return to the family farm.

The chicken infected with avian influenza

The classic signs

After an incubation period of 3 to 5 days, infected birds lack an appetite, no longer lay eggs, and show symptoms in the digestive, respiratory, and nervous systems. The most sensitive individuals die rapidly from hemorrhagic septicemia. In many cases, the mortality rate is brutal, killing nearly the entire population of a hen house within a few hours or days.



Heavy subcutaneous congestion in the abdominal region of a pullet infected with avian influenza in Indonesia, 2004 - © CEVA SANTÉ ANIMALE Indonesia.

A new shared epidemic?

Veterinarians, like doctors, know that infected animals can transmit pathogenic agents to the humans who care for them or who eat them. This is called a zoonosis. In regards to bird flu, cases of infection are noted when there is close contact between humans and animals. Although this is not a new phenomenon, it is often misunderstood or ignored.

An old acquaintance

Avian influenza is a poultry disease dreaded by farmers. It effectively can provoke a very high mortality among infected broilers and laying hens, turkeys, quail, guinea fowl, ostrich, geese, and ducks. It first was described clinically in 1878. In 1902, the causative agent was proven to be a virus. This agent was specifically identified in 1961. Avian influenza viruses that either are not or are only slightly pathogenic circulate in all countries, most often without consequence or with a weak impact on the health of poultry.

In contrast, highly pathogenic avian influenza (HPAI) viruses provoke a scourge known as **fowl plague**. When spread over a large geographic area, they result in economically devastating epidemics.



*Duck market
in Vietnam, 2003
Jean-Charles Maillard,
© Cirad*

Another disease

The term, **pseudo-plague**, is reserved for Newcastle disease. This is as dangerous for young chickens as avian flu. Furthermore, it presents the same clinical signs, lesions, and epidemiologic profile. Geese and ducks are less affected.

The point of view of poultry farmers

Commercial farmers

A HPAI epizootic is a catastrophe impossible to hide. It causes sudden and massive mortality among chickens that are raised intensively. In countries equipped with a well developed veterinary infrastructure, commercial poultry farmers have no choice but to actively cooperate with the veterinary services by declaring a suspect case, accepting the diagnosis, and following the control measures imposed by the official veterinary services: the culling of chickens that are still alive, the disposal of the carcasses according to strict bio-security standards, the thorough disinfection of the site and material, the quarantine of the farm, the provision of compensation, and the strict surveillance of movement and of other birds in a several kilometer radius from the outbreak. The greatest amount of transparency on the part of health authorities is obviously indispensable for the proper management of this type of crisis.



Backyard ducks in Niger, 2006 – Alexandre Caron, © Cirad

Small farmers

An outbreak of HPAI on a small farm is a catastrophe because the farmer knows that all of his animals will either die or be culled while the compensation measures in many developing countries are very uncertain. Consequently, there is a strong temptation to kill a sick animal at the first sign of disease to eat, sell, or – if it already is dead - discretely get rid of the body. Without specific information and sensitization, a farmer will say nothing to neighbors or the authorities. This attitude is understandable when the authorities in a country, although alerted to the risk, do not diffuse information for fear of a negative impact on exports, commerce, tourism, and more generally the overall reputation of the country.

The transmission risk

H5N1 virus transmission through the digestive system has not been noted in humans. The main mode of human contamination is through ocular or respiratory routes. It is therefore necessary to wear protective masks and glasses (in addition to gloves and overalls) when manipulating sick or suspect birds. The risk linked to the consumption of infected poultry is indirect: via the fingers while touching the bird before cooking, then through contact of the hand with the eyes or nose. Swallowing eggs is to be avoided because the virus may be on the shells of eggs laid by a hen in the very first stage of the disease (the hen later will cease to lay eggs). Consequently, hand washing before and after touching food is a simple and efficient preventive measure to be taken without exception.



Industrial battery of laying hens in Cambodia, 2002 – Vincent Porphyre, © Cirad

Frozen chicken, cooked chicken

The consumption of poultry or poultry products (eggs, meat, foie gras...) presents no danger when veterinary control measures are implemented correctly. Products are only made available for consumption several days after poultry are slaughtered, which provides time for a potential infectious outbreak to manifest itself on the source farm.

In case of doubt regarding the efficiency of the control measures, well cooked meat (having a core temperature of 70°C for at least one second, in other words, meat without the slightest trace of pink, including near the bones), presents no risk. A cooked egg also presents no risk. However, freezing does not destroy the virus; it conserves it.

The many forms of HN viruses

Definition of the viruses

The avian influenza virus is a small, infectious micro-organism (approximately one hundred millionth of a millimeter). It is made up of a dozen proteins and of a genome sequence segmented into 8 strands of ribonucleic acid (RNA). Like all viruses, the bird flu agent is by necessity an intracellular parasite: it can only replicate itself within a cell in which it has taken over the metabolism. To enter a cell, the virus must bind onto a specific receptor on the surface of the host cell. This capacity determines which cells are sensitive to infection and which species are vulnerable to becoming infected. Thus, influenza viruses are highly host-specific, avian viruses having much more affinity for avian cells than for human cells (and vice versa). The virus must adapt to a new species in order to jump across the species barrier.



*Traditional brooder house
in Vietnam, 2005
Vincent Porphyre, © Cirad*

The influenza viruses

Members of the Orthomyxoviridae family placed in the Influenza genus, all avian influenza viruses have in common internal type A antigens.

The subtypes that affect birds are characterized by external antigens, some are haemagglutinins H (16 different kinds are known, from H1 to H16), others are neuraminidases N (9 different kinds are known, from N1 to N9).

There are 23 known H-N associations (of which 15 are found in birds) out of 135 potential ones. A slight modification or recombination of viruses of different lineages is sufficient for the creation of new and potentially virulent strains. On numerous occasions (e.g., in Italy and Mexico) H7N1 and the H5N2 strains, which initially were not very pathogenic, became extremely virulent in just a few months.

The pathogenic power of H

Numerous strains of the avian influenza virus, including the subtypes H5, H7, and H9, exist completely unnoticed in wild and domestic bird populations. In contrast, certain strains belonging to the same type may be very virulent and provoke up to 100% mortality. The pathogenicity of a strain is linked closely to the ability of haemagglutinin to cleave into two functional subunits required for the virus to penetrate the cell. This catalysis is facilitated in highly pathogenic strains by the presence of basic amino acids duplicated at the cleavage site, rendering it more accessible to the enzymes involved. Genome sequencing of the cleavage site reveals the pathogenic character of an avian influenza virus strain.



Traditional local commerce of hunted wild birds in Mopti, Mali, 2006
Alexandre Caron, © Cirad

A fragile virus?

If it is protected by moist organic material, the virus can survive well in the environment. It remains infectious for 4 days at 22°C, 30 days at 0°C in contaminated water, and 40 days in poultry droppings. However, it may be destroyed by exposing it to temperatures of at least 70°C for one second during the preparation of food products (meat, eggs...).

A family of unpredictable viruses

The large H.N. family

The avian influenza viruses are programmed to make use of cells in the respiratory and digestive tracts to multiply. They provoke epizootic outbreaks that are well known to veterinarians. Apart from the H9 subtype virulent in poultry, the H5 and H7 subtypes currently are host to the most aggressive viral strains.

Highly pathogenic avian influenza outbreaks in the world

1959	Scotland	H5N1
1963	England	H7N3
1966	Ontario (Canada)	H5N9
1976	Victoria (Australia)	H7N7
1979	Germany	H7N7
1979	England	H7N7
1983	Pennsylvania (USA)	H5N2
1983	Ireland	H5N8
1985	Victoria (Australia)	H7N3
1994	Queensland (Australia)	H7N3
1994	Mexico City (Mexico)	H5N2
1994	Pakistan	H7N3
1997	New S. Wales (Australia)	H7N4
1997	Hong Kong	H5N1
1997	Italy	H5N2
1999	Italy	H7N1
2002	Hong Kong	H5N1
2002	Chile	H7N3
2003	Netherlands	H7N7
2004	Pakistan	H7N3
2004	Texas (USA)	H5N2
2004	British Columbia (Canada)	H7N3
2004	South Africa	H5N2
2005	Southeast Asia	H5N1
2005	China	H5N1
2005	Romania	H5N1
2006	Turkey	H5N1
2006	50 countries infected by	H5N1

The genetic drift strategy

Type A avian influenza viruses are varied and unpredictable because they use a short term survival tactic. Through slight genetic modifications, they escape the immune defenses of a host while exploiting for as long as possible the population vulnerable to the infection.

Two mechanisms at play

Genetic drift occurs through an accumulation of replication errors in a slow process to which organisms may adapt themselves. It is responsible for an antigen shift that allows a virus to partially escape a host's immune response or to progressively adapt to a new host species.

In contrast, genetic reassortment occurs when two viruses trade genetic material, which is only possible if the same cell is infected simultaneously by these two viruses.



Sacred ibis flying in the sky over Chad, 2006 – Alexandre Caron, © Cirad

Feared combinations

Genetic reassortment can have two consequences: a major antigenic modification and the acquisition of new characteristics of virulence or adaptation to a host species.

The combination of these two consequences resulted in the emergence of the viruses responsible for the Asian (1957) and Hong Kong (1968) flu in humans, springing from a recombination of a human and an avian virus. Three of the genes in the 1957 H2N2 virus came from an avian influenza virus and the 5 other segments came from a H1N1 virus derived from the virus responsible for the Spanish flu (1918-1919).

From birds to other animals

All birds are concerned

The disease has been well described among domestic birds such as turkeys and chickens. However, all domestic and wild birds (including migratory ducks and geese) probably are vulnerable to the HPAI H5N1 virus. Migratory ducks play an important role in the spread of the virus across far distances. Water that is contaminated by infected bird droppings can serve as a passive vector for the most vulnerable species such as swans, which should be considered more as victims of the disease than as responsible for its spread. Domestic birds might become contaminated through contact with infected wild birds or water polluted with the HPAI H5N1 virus. Conversely, wild birds might become contaminated through contact with infected domestic birds or water polluted with their droppings or by domestic by-products that commonly are used as feed on fish farms in Asia and Africa.



Domestic and wild ducks on a rice paddy in Madagascar, 2005 – Renaud Lancelot, © Cirad

And ostrich?

Ostrich farming has been developed world wide. In South Africa, an epizootic of influenza among these birds caused a direct (mortality) and indirect (the interdiction of exports) losses estimated at several tens of millions of euros in 2004.

When the flu is shared

Under certain circumstances, viruses with avian origins may infect mammals (pigs, horses...), or even humans.

Nonetheless, this infection generally remains invisible. Wild (tigers in Thailand) or domestic (cats) felines have fallen ill or died after ingesting birds that died of avian influenza, or by having close and repeated contact with sick birds or their droppings. To date, such events are rare and there is little evidence that cats play a significant role in the transmission of the pathogenic H5N1 virus. However, genetic evolutions (mutation, reassortment) may allow a virus to adapt itself to a new host species. Great vigilance is required faced with this risk of crossing the species barrier.



*Sample taken from a red-tailed godwit, traditionally hunted in Mali, 2006
Alexandre Caron, © Cirad*

Commercial exchanges and hygiene

All evidence indicates that uncontrolled commercial movements and a lack of hygiene are much more effective than migratory birds at rapidly transmitting the virus to numerous farms in a given region. Examples are the movement and markets of live birds and the importation of hatching eggs or of chicks of suspect origins. However, the respective contribution of wild birds and of commercial exchanges is difficult to quantify : it is a research question which several teams are studying actively.

Avian influenza in poultry

Highly variable symptoms

The virus penetrates a bird's respiratory and intestinal membranes to infect the cells which will insure its replication. The incubation period is short: 3 to 5 days in general, although it may be up to 3 weeks. This upper limit was retained in international regulation for the exchanges of birds and bird products.

With highly pathogenic H.N. viruses, the acute forms are common: in 90% of the cases, the birds suffer a septicemic attack and die within one or two days. With extreme forms, symptoms may be observed in isolation or in various associations, including general (loss of appetite, prostration...), cutaneous (oedema, congestion, hemorrhage in the combs and wattles), respiratory (respiratory difficulties, rattle, cough), digestive (diarrhea with occasional white droppings, possibly hemorrhagic), and neurological (poor motor coordination, wing paralysis, stiff neck...) signs.

In subacute forms, birds suffer from respiratory symptoms (swelling of orbital sinuses, respiratory difficulty, cough) and cease to lay eggs. Mortality rates still may be high, differing from what is observed in mild cases: slight respiratory symptoms and a reduction in egg laying. Finally, forms showing no visible symptoms are frequent among wild birds.



Veterinary and conservation agents discussing a sampling frame to detect avian influenza viruses in migrating birds in Mali, 2006 - Alexandre Caron, © Cirad

Vulnerable domestic species

Chickens and turkeys are the most vulnerable domestic species. Pheasants, quail, guinea fowl, and ostriches are susceptible, as are geese and ducks. In enzootic zones, numerous domestic and wild species (chickens, geese, ducks...) might be reservoirs for the H5N1 virus, a small proportion of birds (0.1% to 2%) seeming capable of harboring the virus without showing symptoms. These birds might thus contaminate other birds. Pigs, horses, cats, and people may become infected by H5N1 and other avian flu viruses. In Asian zoos, carnivores accidentally fed chickens infected with H5N1 developed severe pneumonia and died.



From beak to snout: mixed farming of pigs and chickens in Vietnam, 2005 – Vincent Porphyre, © Cirad

In addition to their own specific influenza viruses, pigs also may harbor viruses of both human and avian origin (a situation seen in China in 2004 and in Indonesia in 2005). Consequently, it is important to avoid contact between pigs and poultry to reduce the risk of the emergence of a hybrid virus potentially dangerous to man.

Avian flu in man

A very rare disease

Human cases remain exceptional: man is naturally resistant to avian flu. Repeated and close contact with diseased or dead birds is necessary for infection to take place. Humans are infected through their eyes, developing a generally benign form of conjunctivitis (the case of the H7N7 virus in the Netherlands in 2003), or through the deep inhalation of particles that may provoke a severe respiratory infection. The incubation period lasts between 1 and 2 weeks before the first symptoms appear: high fever, headaches, muscular pain, fatigue, cough, and respiratory difficulty. In certain cases, these symptoms evolve rapidly into acute respiratory distress that can lead to death.

The human victims

As of August 2006, the virus has provoked 241 confirmed human cases of avian flu in Southeast Asia, Turkey, Iraq, and Egypt, with a mortality rate of approximately 60% (the proportion of deaths among diagnosed cases). These cases must be considered in the context of the hundreds of millions of people exposed. It may thus be affirmed that the transmission of H5N1 from poultry to man is an exceptional phenomena that always is linked to extremely poor hygienic and sanitary conditions. In contrast, human influenza viruses are the indirect cause of several hundred thousand deaths each year around the world.

- 1997: 18 people are infected with the H5N1 virus in Hong Kong, 6 die.
- 1999 and 2003: the H9N2 virus is found in three people in Hong Kong, they develop only minor symptoms.
- 2003: the H7N2 virus is discovered in a man suffering from a severe flu in the state of New York (USA).
- 2003: the H7N7 virus infects several dozen people in the Netherlands who were in contact with sick birds, provoking conjunctivitis. A veterinarian dies following infection from the virus.
- Since the resurgence of the H5N1 epizootic in Southeast Asia in 2003, 241 people have been infected, of which 141 have died (August 2006). This figure evolves from week to week, the most frequent cases currently being found in Indonesia which is having difficulty controlling the epizootic. The last reported cases of deaths outside of Asia were in Turkey, Iraq, and Egypt.

From person to person

The transmission of the HPAI H5N1 virus from an infected person to a healthy individual is extremely rare. A substantial mutation of the existing HPAI H5N1 virus strains would be required for this to be more frequent. Its occurrence would change the nature of the disease and considerably increase the risk of a pandemic caused by the mutant virus.



Plucking captured wild bird in Mopti, Mali, 2006 – Alexandre Caron, © Cirad



Poultry market vendor in Vietnam, 2003 – Jean-Charles Maillard, © Cirad

Once upon a time, there was the Spanish Flu

The Spanish Flu of 1918-1919

The culprit H1N1 virus killed over 40 million people between 1918 and 1919, a total that may be compared to the 8.3 million soldiers killed between 1914 and 1918 during World War I. The virus began in China and first circulated through Europe and the United States of America onboard troop transports, then reached Southeast Asia and Africa through land, sea, and air routes. Initially, it was not particularly deadly; the people who fell ill often recovered after suffering only a few days of fever. In a second wave, the virus became ten times more dangerous to the point of becoming lethal among healthy people between the ages of 15 and 35; in contrast, "ordinary" flu statistically affects the youngest and oldest in a population. At the time, it was thought that older people were spared because they had experienced the flu of 1889-1891 and survived.



Some authors believe that the lethal character of the virus may have been acquired on pig farms located on the Great Plains of North America. Deaths were caused by severe primary viral pneumonia that developed very fast (2 days), as well as by secondary bacterial infections caused by *Haemophilus influenza*, a bacteria species involved in deadly pneumonias and pleurisy.

The name, Spanish Flu, is due to a rumor that the source of contamination in Europe was canned food imported from Spain that supposedly was poisoned by German spies.

During the pandemic, 25 to 30% of the worldwide population caught the flu. Life expectancy dropped 10 years in the space of only a few months. India counted 10 million dead. The United States of America lost 500,000 of its citizens, or more than the cumulated losses from the two World Wars, the Korean War, and the war in Vietnam. In France, 400,000 young adults died. Certain Polynesian islands lost 20% of their population while at the same time 60% of Inuits disappeared. Wearing face masks became a daily reality at work and on public transport.

Pigs also were victims of the epidemic, either due to their role in the appearance of the virus, or by transmission from infected people.

Extracts from a medical thesis (1919)

"Despite active treatment: bleeding in the beginning, daily colloidal silver, camphor oil, strychnine, cold packs, fixation abscess, subcutaneous injections of oxygen, by the sixteenth day, the patient succumbed to the flu."

The Spanish Flu rediscovered in 2005

American researchers recreated in a laboratory a virus similar to an avian H1N1 virus. They used a Spanish flu virus discovered in the bodies of Inuits which had been conserved in frozen Alaskan soil for nearly 90 years. The researchers were able to verify the virus' highly pathogenic nature on cultures of human pulmonary cells.

Short questions

Brief responses

◀Why cannot people be vaccinated with the vaccine used for poultry?

Each vaccine is adapted to the species for which it is destined. The immune system of birds is different from man: a vaccine that works for birds will not necessarily be effective for people. In addition, the vaccine used in several parts of the world (e.g., Mexico) against avian influenza only provides immunity for a short time (several weeks) in vaccinated birds.

◀Why get vaccinated against human flu if this will not protect against avian flu?

(1) Because the human flu virus remains by far more wide spread among people than that of avian flu, (2) to avoid having someone accidentally infected by avian flu also become infected with human flu, which would facilitate the emergence of a potentially dangerous hybrid virus, and (3) to facilitate a differential diagnosis in the case of flu symptoms.

◀Bird flu or avian influenza?

The term avian influenza is preferable because it is less easily confused with the human disease (the flu) and it does not imply that birds are infected with a disease that resembles the human flu.

◀What does influenza mean?

Etymologically, influenza comes from the Italian «influenza di freddo», or influence of the cold. No distinction is made from a banal cold.

◀Are all viruses dangerous?

No, most are inoffensive or benign. Numerous types of influenza viruses pose no threat to people. Certain other viruses known as bacteriophages are used as biological tools to destroy pathogenic bacteria.

◀How many duplicated viruses can a living infected cell produce?

A sole virus that has infected one cell can lead to the production of several hundred new viruses in two or three days.

◀Has the H5N1 virus evolved since 1997, the date when research for a vaccine began?

Yes, it is continually evolving.

◀What is infectiosity?

The capacity of a pathogenic agent to establish itself in a host of a given species in order to multiply there.

◀What is an epizootic?

The sudden increase in the number of animals infected by a disease in a given region and during a given period of time.

◀What is an enzootic?

An infectious disease affecting one or several species of a region that does not tend to spread and which is permanently present at certain times of the year.

◀When does one speak of an epizootic or an epidemic?

The term epidemic is generic and may be applied to diseases affecting people, animals, and plants. The term epizootic refers specifically to an epidemic affecting animals. It is preferable to use this term in the case of avian influenza to avoid the suggestion that the disease is contagious between people, which has not been observed to date.

◀Should one speak of a panzootic?

Commonly the term panzootic refers to animal epidemics and the term pandemic is used for human epidemics. In the beginning of 2006, the H5N1 panzootic was confirmed, the H5N1 pandemic is still only feared.

◀What is a pandemic vaccine?

A vaccine against a virus capable of provoking a large scale epidemic.

◀Why would a genetic recombination of avian and human viruses be dangerous?

Genetic recombination may take place in a human or in an intermediary host such as a pig. The sudden change of antigens in a virus that has been recombined and adapted to a new species creates the conditions for a major epidemic in a population that has no pre-existing immunity.

◀Virulent or contagious?

A virulent virus provokes a serious disease in the host. A contagious virus is transmitted easily from one individual to another. A contagious virus may not be very virulent. A virulent and contagious virus always is to be greatly feared.

◀What became of the Spanish Flu virus?

Very mild pathogenic forms of viruses resembling the one that caused the deaths of 40 million people between 1918 and 1919 continue to circulate among wild bird populations without having changed considerably.

◀Is there an estimate of how many chickens there are in the world?

Approximately 100 billion.

◀The H5N1 virus is an occasional pathogenic agent in man. Are there others?

Out of 1,400 viruses, bacteria, fungus, champignons, protozoa and worms harmful to the health of people, 60% are shared with animals.

◀Are more and more pathogenic agents affecting people?

Not necessarily, but it is true that new research methods has enabled the description of about forty such pathogenic agents since 1980 (for example, the Creutzfeld-Jakob disease prion, the SIDA virus, the SARS coronavirus).

◀What is behind the increase in health risks?

An acceleration of trade, environmental change, global warming, an increase of immunodeficient populations (elderly or under treatment), a decrease in hygiene.

◀How many chickens can coexist on one industrial farm?

Up to 1.25 million individuals in California (USA).

◀Did the current avian crisis begin in 1997 or 2003?

In 1997, a HPAI H5N1 virus caused disease in both man and poultry in Hong Kong. Eighteen human cases were recorded, 6 of which were fatal. In December 2002 and January 2003, new outbreaks were reported in Hong Kong in poultry and wild birds. At the end of 2003 and beginning of 2004, multiple outbreaks occurred in Southern Korea and Indonesia, then in Vietnam, Japan, Taïpeia China, Cambodia, Laos, Thailand and China. Different strains of HPAI H5N1 probably had been circulating in South-East Asia for several years and were only reported in some places. A conjunction of triggering factors such as a cool and wet climate, increased density of domestic birds, and more intense commercial exchanges (New Year feast) were probably at the origin of the epizootic.

◀Is the clandestine poultry trade widespread?

It is substantial but difficult to quantify. It was probably behind the dissemination of avian influenza from Nigeria to Niger, Burkina Faso, Cameroon, and the Ivory Coast.

◀Caught bird flu, will I recover?

Poultry farmers have caught avian influenza and spontaneously recovered. Others died after a tardy diagnosis and a lack of support for vital functions during hospitalization. For those who fall ill, an antiviral treatment taken at the start of the infection improves one's chances of recovery.

◀How many deaths have there been in 2 years?

One hundred and forty one deaths (17 August 2006) spread across a dozen countries, out of several million people that might have become infected. This figure is far lower than the number of deaths due to ordinary human flu (several hundred thousand per year worldwide).

And Asia?

The People's Republic of China recently decided to restructure its veterinary services to conform to OIE (World Organization for Animal Health) recommendations. This change resulted in an increase in the declaration of avian influenza outbreaks: from August 2005 to April 2006, 28 declarations (chickens, partridge, ducks, geese) were made to the OIE in 14 provinces, including Tibet and Inner Mongolia, leading to the death or the culling of 400 000 birds. As of April 2006, 18 human cases of infection were confirmed since the beginning of the epizootic, of which 12 were fatal. Recent studies indicate that the H5N1 virus started from an enzootic zone in the south of the country and was able to contaminate other regions of China and the world due to both the commercial movement of poultry and poultry products and the migration of wild birds.



Flight of white-faced whistling ducks accompanied by summer blue winged teal and comb ducks, 2006 - Alexandre Caron, © Cirad

And the Middle East?



*Destruction after sampling of bird carcasses and sampling materials, 2006
Alexandre Caron, © Cirad*

And Turkey?

As the eastern region of Turkey borders on several countries, there are two conflicting hypotheses explaining the introduction of H5N1: it either was due to migrating birds, Turkey lying along one of the principal migration paths of birds nesting in Siberia, or to uncontrolled commercial movements. During the first trimester of 2006, outbreaks among animals were observed in 7 provinces. Twelve cases among humans were confirmed, of which four led to death. Human cases were reported at about the same period in Iraq, but no information was available regarding the situation among animals. In August 2006, several months passed without a new human or animal case in Turkey, while several outbreaks affected Egypt (14 human cases – the last one in May 2006, of which 6 were fatal), the Gaza Strip, Iran, Israel, and Jordan.



Industrial battery of laying hens, 2002 - Vincent Porphyre, © Cirad

And Africa?

By August 2006, 8 African countries were known to have been infected by the HPAI H5N1 virus: Burkina Faso, Cameroon, Côte d'Ivoire, Djibouti, Egypt, Niger, Nigeria and Sudan. This virus was introduced to Africa either through the commercial importation of eggs or day-old chicks from infected countries, or through migrating birds for whom Nigeria and Egypt are important winter destinations. Uncontrolled commercial movements between African states also should be considered. It is probable that the wide spread Egyptian epizootic (14 governorates infected by the end of August 2006) caused the contamination of Palestine, Jordan, and Israel. It is feared that the infection, starting from outbreaks in Egypt and Nigeria, will propagate itself and spread through countries of northern, western, and eastern Africa, in other words, throughout the entire African continent and the Arabian peninsula.



Industrial poultry battery, 2006 - Vincent Porphyre, © Cirad

The H5N1 virus is likely to cause heavy economic losses as much at the national level as at that of rural African families. The promiscuity of poultry and people in the villages increases the risk of human cases. The diversity of the ecosystems infected leads to the fear that the disease may become endemic, meaning that it may quietly circulate only to suddenly remerge given favorable climatic conditions or an encounter with an animal population receptive and vulnerable to the disease. The recommended control measures are slaughtering at an outbreak area and vaccination around the contamination point. These measures require the coordinated mobilization of local populations (supported by wide scale information campaigns), countries, and international assistance.

And Western Europe?

The H5N1 virus was introduced into Western Europe by wild birds coming from the East during the winter of 2005-2006. Only two commercial turkey farms were affected during this period: one in France and one in Germany. Past episodes of avian influenza in Europe allows one to think that official veterinary services will be able to control the health situation. Likewise, it should be possible to avoid the contamination of humans, or at the least limit it to exceptional cases. On the other hand, the economic losses in the commercial poultry sector already are enormous. The persistence of outbreaks in Eastern Europe and the spread of the epidemic in the Middle East and Africa will enable the menace to hover over all of Western Europe for several years.



Poultry farm above a fish pond in Cambodia, 2002 - Vincent Porphyre, © Cirad

Active prevention among animals

In relation to poultry

- Avoid contact between domestic poultry and wild birds, protect watering holes and feed troughs with fences or nets.
- Quarantine (the optimal period is 3 weeks) birds recently introduced or reintroduced (ex: unsold animals returning from markets) before mixing them with the flock on the farm.
- When there is an abnormally high mortality rate among bird stock, immediately alert the closest veterinarian or veterinary services.
- Farming birds in single-age flocks allows better control of disease in general.
- Although the advantages of vaccination in general are well known, the ideal vaccine against H5N1 does not yet exist. In effect, certain vaccines in circulation were made from an inactive strain of H5N2.
 - Cross protection with the H5N1 virus therefore is not perfect, and the inactive character of the vaccine leads to an immunity of short duration. To obtain a satisfactory level of protection, two initial injections are required, followed by regular booster injections among birds with long life spans (laying hens, breeding birds). This treatment is expensive and involves repeated handling of the animals. Such practices are possible on modern farms, but are problematic for smallholders in Asia or Africa with free-ranging birds.
 - The vaccine protects the bird against the disease, but does not guarantee that the wild HPAI H5N1 virus will not replicate itself in the digestive system of the bird if the vaccinated bird was exposed to the infection. Such a bird could then disseminate the virus and contaminate other birds that were not vaccinated.



*Poultry stall in a
Vietnamese market, 2003
Jean-Charles Maillard,
© Cirad*

In relation to other animals

- Separate the different species raised on the farm (e.g., ducks, pigs).
- Avoid contact with other animals, notably dogs, cats, and rodents.
- Follow closely the recommendations of the veterinary services concerning confinement and vaccination.



Meeting of pigs, chickens, and a dog over waste water in Madagascar, 2005 - Renaud Lancelot, © Cirad

In relation to material, equipment, and vehicles

- Do not allow soiled material, equipment, or vehicles to enter the farm.
- Material and equipment should be cleaned and disinfected regularly (egg trays, cages...).
- Avoid using materials that are difficult to disinfect (wood, fibers...).
- Control the origin of water and food that may be a source of contamination.



*Donkey transporting a nomadic Peul shepherd's camp in Niger, 2006
Alexandre Caron, © Cirad*

Active prevention among people

In relation to people

- Reinforce customary hygiene rules, such as washing hands and food.
- Hunters should not handle dead wild birds with their bare hands.
- At risk professionals (poultry farmers, veterinarians, livestock technicians...) should have protective equipment at their disposal (gloves, masks, goggles, overalls) and should use them whenever there is the slightest risk. In case of exposure to suspect birds or products, they should consult a doctor without delay.
- Leave specific clothes (shoes, jackets...) at one's work site, and wash equipment regularly.
- In the kitchen, wear gloves to pluck, clean, and cut up birds. Wash hands with soap before and after handling poultry carcasses. The consumption of poultry meat requires proper cooking (70°C for at least one second in the heart of the meat); the same principal applies to eggs.
- Forbid access to bird-stock buildings to people not working on the farm who could contaminate birds through their clothes, shoes, or hands (veterinarians, technicians...). Protective clothing must be put at their disposal.
- Footbaths (to disinfect feet and shoes) must be available at the entrance of each building and be maintained (disinfectants renewed every other day).
- Require hand washing before and after entering areas where animals are kept.

Transport of poultry in a cage on a motorcycle in Vietnam, 2002
Doan Hong, Projet PCP - Malica / Paule Moustier of the Fruit and Horticulture Department (Flhor) © Cirad



Stringent bio-security

Even in the absence of an outbreak or of suspect cases, sanitary precautions must be strictly observed along the entire production chain, from farms or cooperatives to slaughterhouses, without overlooking food preparation factories or means of transport. For example, eggs must not be sold less than 4 days after being laid in order to leave time for possible diseases in incubation to manifest. If such is the case, this allows the eggs to be withdrawn from the distribution chain. When the risk of avian influenza is high, these measures are reinforced.



Flight of whistling ducks in Niger, 2006 - Alexandre Caron, © Cirad

Antiviral treatments

Access to antiviral medicines is difficult for populations in developing countries – the people most vulnerable to avian flu. If a human case is suspected, the sick person must be taken immediately to a hospital as the antiviral treatment is only effective if it is administered within several hours of the first sign of symptoms.

Control of contagious outbreaks

When an outbreak is confirmed

- Movement of animals is forbidden (put under quarantine).
- Movement of people is restricted: limited possibility to leave the site with a required stop at a control post and disinfection of the means of transport.
- Complete slaughter of birds present and incineration and/or burial of dead or slaughtered animals and their products.
- Complete disinfection of buildings, equipment, and infected areas.
- Complete sanitary isolation for 21 days.



Laying hen farm in Madagascar, 2006 - Renaud Lancelot, © Cirad

An infected zone

Within a 3 to 5 km radius (depending on the concentration of poultry present in the zone and the associated epidemiological risks):

- Complete slaughter of the poultry present in the zone where compensation is available: compensation measures are necessary if the livestock farmers concerned are to accept the slaughter of their birds instead of hiding them and contributing to the maintenance of the infection.

and/or

- Vaccination of birds.
- Prohibition of moving birds and their products.
- Limits on the movement of people (anyone exiting the zone must pass through a control post and the means of transportation must be disinfected).

Protection zone

Within a 5 to 10 km radius (or farther):

- Vaccination of birds.
- Prohibition of moving birds and their products.
- Limits on the movement of people (anyone exiting the zone must pass through a control post and the means of transportation must be disinfected).

Surveillance zone

On the remainder of the territory:

- Prohibition of bird markets and other forms of bird gatherings (races, fairs, exhibitions...).
 - Reinforcement of the surveillance of poultry farms.
 - Reinforcement of on-farm bio-security measures.
 - Confinement of birds to buildings that allow a complete separation of domestic and wild birds.
 - No introduction of hatching eggs, day-old chicks or any other bird whose health status is not certified by qualified veterinary services.
 - Strict restrictions on off-farm contacts - people, material, feed, vehicles - accompanied by systematic cleaning and disinfecting measures (footbaths, disinfectant mats, disinfection of egg trays...).
 - Raising birds in single-age flocks and sanitary isolation of flocks to avoid the eventual transmission of the virus from one group to another.
 - Reinforcement of controls on the movement of people and animals within the interior of the country and on the frontiers.
- In each national preparedness plan, the limits of zones to be considered, as well as the length of the enforcement of health measures, are defined by the health authorities.

To destroy the virus

What kills the virus

The external lipidic layer of the viral shell is destroyed by detergents such as soapy water or particular hydro-alcoholic disinfectants. Simple rinsing with water is insufficient because the virus survives well in humidity, cold water, and at moderate temperatures. Bird droppings represent the greatest danger as the virus can remain infectious in them for over one month. A convalescent bird may excrete the virus in its ocular and nasal secretions up to 30 days after the infection.



Geese driven by a small shepherd in Madagascar, 2005 - Renaud Lancelot, © Cirad



Floating market on the river Niger in Mopti, Mali, 2006 - Alexandre Caron, © Cirad

The price of bird flu

An exorbitant cost

To evaluate the cost of avian influenza, the following must be taken into account • the direct mortality from disease and culling, both of which induce heavy losses for poultry farmers • the cost of surveillance and control (culling, disinfecting, quarantines, surveillance networks, analyses, vaccinations,...) • compensation for poultry farmers in the case of mandatory culling • consumer reticence in western countries to eat poultry, aggravating the crisis in the poultry sector • restrictions on or the prohibition of poultry and poultry product exports • the collapse of tourism in affected countries • damage to their long term image.

Vietnam estimates having lost in this way 200 millions euros in 2004, or 0.5 percent of its gross domestic product.



Egg laying hens raised in cages in Madagascar, 2006 - Renaud Lancelot, © Cirad

The spread over time and space

**Countries infected by H5N1 virus
from 2003 to 2004**



**Countries infected by H5N1 virus
from 2003 to 2005**



Countries infected by H5N1 virus from 2003 to october 2006



The disadvantage of this country-by-country map is that it makes it seem as if an entire national territory is infected when infectious outbreaks are often scattered. The advantage is that it shows the rapid geographic spread of the HPAI H5N1 virus.

Migrating birds, vectors or victims?

Recent studies showed that in some enzootic regions certain aquatic migratory birds, ducks in particular, were carriers of the H5N1 virus without presenting symptoms. The same virus was found on dead birds far from the closest outbreak of HPAI. However, it is certain that commercial exchanges of domesticated birds and their products (eggs, chicks, meat, feathers, and droppings) play a considerable role in the diffusion of the virus in the short and long term. Additional work is needed to identify the degree to which wild migratory and sedentary birds contribute to transmission compared to the movement of domesticated birds and poultry products linked to human activity.

The countries directly and indirectly concerned

Country	First sign (d/m/y)	Species infected	Farm type
South Korea	11/12/2003	Chicken (breeding)	Industrial
Indonesia	11/12/2003	Hen	Farmyard
Vietnam	27/12/2003	Chicken (breeding)	Industrial
Cambodia	11/01/2004	Hen	Industrial
Japan	12/01/2004	Hen	Industrial
Hong-Kong	19/01/2004	Peregrine falcon	Wild
Laos	19/01/2004	Hen	Industrial
Thailand	20/01/2004	Hen	Industrial
China	23/01/2004	Hen, chicken, duck, goose, pigeon	Farmyard
Malaysia	07/08/2004	Hen, chicken, goose, duck	Farmyard
Russia	18/07/2005	Hen, turkey, duck, goose	Farmyard
Kazakhstan	22/07/2005	Duck, goose	Farmyard
Mongolia	02/08/2005	Duck, goose, swan	Wild
Turkey	01/10/2005	Turkey	Farmyard
Romania	04/10/2005	Hen, duck	Farmyard
Croatia	19/10/2005	Swan	Wild
Ukraine	25/11/2005	Chicken, goose	Farmyard
Nigeria	10/01/2006	Hen	Industrial
Iraq	18/01/2006	Chicken, hen, goose, duck, wild birds	Farmyard and wild
Azerbaijan	29/01/2006	Wild birds	Wild
Greece	30/01/2006	Swan Wild	
Italy	01/02/2006	Mute swan Wild	
Iran	02/02/2006	Swan	Wild
Bulgaria	03/02/2006	Swan	Wild
Hungary	04/02/2006	Mute swan	Wild
Germany	08/02/2006	Swan, goshawk	Wild
Slovenia	11/02/2006	Mute swan	Wild
Austria	13/02/2006	Swan	Wild
France	13/02/2006	Wild duck	Wild
Niger	13/02/2006	Chicken, duck	Farmyard
Myanmar (Burma)	13/02/2006	Hen, quail	Farmyard
Bosnia-Herzegovina	16/02/2006	Swan	Wild
Egypt	17/02/2006	Chicken, hen, goose, duck, wild birds	Farmyard, industrial and wild
Slovakia	17/02/2006	Smew, peregrine falcon	Wild
India	18/02/2006	Chicken, hen	Farmyard, industrial
Cameroon	21/02/2006	Duck	Farmyard
Georgia	23/02/2006	Swan	Wild
Pakistan	23/02/2006	Hen (breeding)	Industrial
Sweden	24/02/2006	Mallard duck	Breeding
Switzerland	26/02/2006	Common merganser	Wild
Burkina Faso	01/03/2006	Guinea fowl	Farmyard
Serbia and Montenegro	01/03/2006	Swan	Wild
Poland	02/03/2006	Swan	Wild
Afghanistan	02/03/2006	Turkey, chicken	Farmyard
Albania	07/03/2006	Chicken	Farmyard
Denmark	14/03/2006	Tufted duck, swan	Wild
Israel	16/03/2006	Turkey	Industrial
Czech Republic	20/03/2006	Mute swan	Wild
Jordan	23/03/2006	Turkey, chicken	Farmyard
United Kingdom	30/03/2006	Swan	Wild
Côte d'Ivoire	30/03/2006	Chicken, ducks, hawks	Farmyard, wild
Sudan	01/04/2006	Chicken	Farmyard
Djibouti	06/04/2006	Chicken	Farmyard
Spain	30/06/2006	Great crested grebe	Wild

Countries not yet infected or where test results are not yet known

While the approximately fifty countries affected by the disease have suffered its direct negative effects since the beginning of the plague, the 150 countries thus far disease-free have experienced indirect effects such as an anticipated drop in the consumption of poultry that is nevertheless safe, an increase in health control measures, the stimulation of meat substitution sectors, the reorientation of tourism, a strengthening of international solidarity, and an awareness of globalization.



Purchase of a chicken in Vietnam, 2002 - Doan Hong, Project PCP Malica / Paule Moustier of the Fruit and Horticulture Production Department (Flhor), © Cirad



Wire cages in a Vietnamese market, 2002 - Doan Hong, Project PCP Malica / Paule Moustier of the Fruit and Horticulture Production Department (Flhor), © Cirad

International mobilization

One hundred countries, in addition to international human and animal health organizations (including the FAO (1), OIE (2), and WHO (3)), meeting at a conference in Beijing (China) in January 2006, decided to donate 1.9 billion US dollars for the prevention of a potential human avian flu pandemic. The World Bank, Europe, and the United States respectively are supposed to provide 500, 121, and 334 million US dollars to fight avian influenza. The participants emphasized the necessity of coordinating activities to consolidate the global system for disease control and diagnosis.

This system is organized on three levels:

A world forum defining veterinary policies, alliances between international organizations, the private sector, and consumers, and the establishment of coordinated communication policies for the management of risk related to animal diseases;

A regional coordination of efforts in partnership with the appropriate competent organizations, the FAO, and the OIE to facilitate the implementation of regional policies and provides necessary technical support through evaluations of veterinary services, reinforcement of skills, and the provision of expertise to countries who request assistance;

At the national level, an evaluation of veterinary services in order to prepare the investments required for the prevention and control of avian influenza and other emerging diseases. It also facilitates an evaluation of a country's skills capacities and the constitution of alliances between official veterinary services and the private sector (including farmers), for example in the implementation of national compensation mechanisms for poultry farmers during culling campaigns following disease outbreaks.

(1) FAO: Food and Agriculture Organization of the United Nations

(2) OIE: World Organization for Animal Health

(3) WHO: World Health Organization

Sanitary restrictions on imports

To avoid introducing avian influenza into a disease-free zone, all imports of birds or bird products must be inspected by the veterinary services of the country of origin and destination. The importer must present an international veterinary certificate which attests that strict and specific conditions were met for the departure of the animals or their products. Depending on the case, these conditions may relate to the health of the animals, the vaccines used, the nature and cleanliness of the packaging, the disinfection measures taken, etc. A precise definition of the norms is given in an international zoo-sanitary code available on the Internet at the following address : <http://www.oie.int>

The certificate is verified at the frontier by border inspection posts that are entitled to make additional inspections, ask for complementary analyses, or even consign or destroy the shipment if there are doubts concerning the documents or if a health problem is noted upon arrival.

Indispensable references

- The training guide for veterinary auxiliary workers in Vietnam «Prevention and control of avian flu in small scale poultry » a 40 page guide illustrated with 14 figures prepared by AVSF (Agronomes et Vétérinaires sans Frontières / Agronomists and Veterinarians without Borders), 50 000 copies published.

<http://www.livestockworkinggroup.org>

- The documents prepared by the OIE, FAO and AU-IBAR, for information and training purposes, provides general information on avian influenza, the species infected, transmission among birds and between birds and man, farm bio-security, risky practices, communication, transfer of information, the measures to adopt in case of suspect and confirmed outbreaks, drawing samples, avifauna, reference laboratories, culling of poultry and the destruction of cadavers, disinfection of sites, vaccination, preparing the management of health crises, sample documents for the report of suspect outbreaks of HPAI, assistance in deciding on sanitary culling, attestations for the culling and the destruction of poultry, poultry vaccines.

http://www.oie.int/eng/avian_influenza/disease.htm

- The teaching kit prepared by the EISMV (Ecole inter-états des sciences et de médecine vétérinaires / Interstate School of Science and Veterinary Medicine) of Dakar (Senegal) includes an illustrated handbook, pedagogical tools to lead meetings, a posters guide, prepared responses to frequently asked questions, monographs on the disease, slides on a CD-ROM, role play audio messages, and theatrically inspired video spots.

<http://www.refer.sn/eismv>

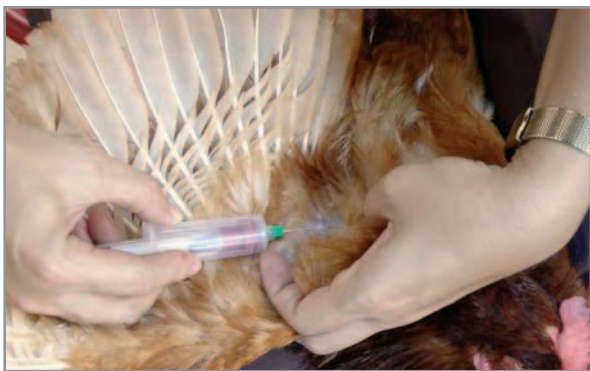
Lessons from bird flu

Negative repercussions

- Collapse of the poultry sector in affected countries.
- Anticipated consumer recoil in retail markets.
- Loss of revenues for small poultry farmers without insurance.
- Large poultry farmers turning to insurance brokers or to the State.
- Diversion of compensation allocated to stricken poultry farmers.
- Reduction in the commercial trade of living material.
- Irrational and pointless destruction of wild birds (nests of swallows, swans...), abandonment of domestic animals (birds, cats).
- Mobilization of funds to the detriment of other subjects receiving less media attention.
- Decrease in tourism.

Positive repercussions

- Evidence of the necessity of training veterinarians in all of the affected countries.
- Growing awareness of the risks linked to emerging diseases.
- Revival of other meat production sectors.
- Capitalizing on previously scattered knowledge.
- Public consciousness raising on current events.
- Revival of veterinary and medical research.



Blood sample drawn from the wing vein of a hen in Cambodia, 2002 - Vincent Porphyre, © Cirad

What has been understood

- It is difficult to draw together the financial, material, and human resources needed to stop the expansion of a panzootic even if the country of origin and the concrete sanitary control measures to be taken are known.
- The media plays an important role in decision making, particularly in democratic countries.
- It is easy to lose sight of the fact that bird flu is principally an animal health problem before being, and this is still very hypothetical, a problem of human public health.

What remains to be studied

Numerous questions still remain concerning the epidemiology of the H5N1 virus (and of other avian influenza viruses), in addition to the potential to improve control measures. The following list is only indicative and not exhaustive:

- The conditions in which the ordinarily mildly virulent H5N1 virus becomes very aggressive.
- The role of wild birds in the transport of the virus over long distances.
- The survival of the virus in tropical and temperate environments when it is protected from direct sunlight, high temperatures, desiccation, and the aggression of diverse chemical agents.
- The possible transformation of the virus genome within the bodies of domestic pigs.
- The impact of avian flu on small farms in Africa.
- The transmission of the virus between domestic and wild birds.
- The risks linked to commercial trade.
- The modification of the spread of the virus at different scales (local, national, international).
- Genetic and immunogenetic resistance.
- The interaction between the virus and host cells.
- The search for new vaccines to better protect domestic and even wild animals.

INRA Research Topics

On the viruses

The H5N1 virus displays a large genetic plasticity; some strains are highly pathogenic while others are harmless in birds. Research into the interaction of each viral protein with the cytoplasmic and nuclear membranous components of target cells and of the host's immune system seeks to better understand the specificity of the virus and to identify appropriate vaccinal and therapeutic approaches. This research is conducted through a study of structures at the molecular scale to examine, for example, the viral M2 protein, the cellular surface proteins of avian hosts and their contacts with sialic acid receptors, as well as the network organization of hemagglutinin proteins.

On the hosts

If the entry mechanisms of viruses into host cells are beginning to be better understood, the interactions between the virus and the intracellular organelles still are not. In addition to the study of vulnerable bird species, the study of species with a natural immunity also is a source of knowledge : resistance to virus entry, resistance to intracytoplasmic transport, or blocking of virus excretion after replication within the cell.

On the vaccines

One research avenue on vaccines is the transport of influenza antigens by viral nanostructures or by Myxoma viruses, herpes viruses, or by canine adenoviruses. The success of this approach depends on several factors : the immune response to the selected influenza antigens and the effectiveness of the vector without undesirable side effects in the targeted host. Research into Orthomyxoviridae in fish may contribute to an understanding into delicate tissue and cellular immunity mechanisms.

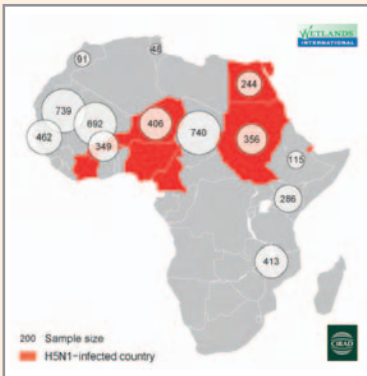
On the dynamics of an epidemic

Within the framework of research undertaken in collaboration with several French organizations (INSERM, CIRAD, the Institut Pasteur and AFSAA), INRA is participating in the surveillance of sentinel species (man, domestic animals, wild animals) in Europe as in Asia and Africa, tackling the latter two continents in cooperation with CIRAD.

In 2006, eight INRA researchers are working full time on joint research units with CNRS, the French vet schools, and AFSSA.

Surveillance in wild birds

During the summer and fall of 2005, the HPAI H5N1 virus quickly spread from South-East Asia to Siberia, then to Eastern and Western Europe. Two non-exclusive hypotheses might explain this phenomena: the trade of bird products (live animals, eggs, meat...), or the local and long-distance transmission by bird migrations. For the latter, many water birds breed in Eurasia and winter in the sub-Saharan regions of Africa. In African wetlands, these birds are in close contact with a variety of Afro-tropical water bird species but the transmission risk between Eurasia and Africa is poorly understood. A survey was funded and implemented by the FAO in early 2006 to investigate the carriage of H5N1 or other HPAI virus strains in wild-bird populations wintering in Africa. Field activities were coordinated by CIRAD and Wetlands International. Sampling sites were selected among bird-wintering areas of major interest (see map). Other sites were added following H5N1 outbreaks in Egypt, Niger and Burkina Faso. Most field operations were conducted between January and March 2006 in collaboration with international conservation and research organisations, NGOs, hunting associations, and safari operators. The target bird species were selected from families previously identified as AI reservoirs (ducks, waders, gulls, etc.). About 5,000 samples were collected in 13 countries: cloacal swabs (birds shot and provided by hunters, netted birds) and fresh droppings at roosting areas. Most were shipped to Istituto Zooprofilattico Sperimentale delle Venezie (Italy), a FAO/OIE reference laboratories for AI.



No HPAI virus was detected, nor was any evidence of the circulation of H5N1 viruses in wild birds, including in countries that had experienced recent outbreaks. This result should be interpreted cautiously due to the small size of the sample compared to the millions of water birds in the target population. It is coherent with the absence of H5N1 virus

reported by surveillance programmes in European countries, and with the very low prevalence of H5N1 virus reported so far in healthy wild bird populations in China. A new wildlife survey is implemented by the FAO in Eastern Europe, the Middle East and Africa during the boreal winter of 2006-2007 to bring new evidence for the role - or the lack of a role - of wild birds in the dissemination of HPAI viruses. The first results are expected in November 2006.

From fear to hope

Six reasons to fear a mixed human-avian virus

if

- the hybrid virus becomes regularly mortal for man,
- the hybrid virus is revealed to be highly contagious between people,
- the specific vaccine is not available in time or in sufficient quantities,
- virus prevention is discovered to be less effective than foreseen,
- the world is not ready to fully react in time,
- new diseases add themselves to the effects of the virus which may facilitate the action of other pathogenic agents or engender the economic collapse of sectors.



Smoking of whistling ducks in the bush in Chad, 2006 - Alexandre Caron, © Cirad

Six reasons for hope

because

- other outbreaks of avian influenza ended by themselves,
- scientists are proposing measures to end the crisis,
- the initial outbreaks were controlled,
- new therapies will be proposed,
- natural forms of resistance will appear,
- avian influenza will be controlled before the fatal viral mutation materializes.



Attempt to capture a domestic duck in Niger, 2006 - Alexandre Caron, © Cirad

The concrete actions in which CIRAD is engaged

Before 2005

- Technical support, training, and epidemiological surveillance and support missions in Asia (Vietnam, Cambodia, China);
- Participation in national and international meetings and in the OFFLU network (Global Scientific Network for the Control of Avian Influenza) jointly created in April 2005 by the OIE and the FAO. These activities continue in 2006.
- Participation in training programs within the framework of technical cooperation projects (TCP) in Asia.

Since 2006

- Contribution to technical cooperation projects (TCP) against avian influenza set up by the FAO to benefit the countries of Eastern Europe, the Middle East, and Africa through:
 - capacity reinforcement of veterinary services in epidemiological surveillance networks of domestic and wild birds and risk analysis, working in collaboration with the Royal Veterinary College of London;
 - an epidemiological study of the transport of the H5N1 virus by wild avifauna in collaboration with Wetlands International, the ONCFS (National Office for Hunting and Wild Fauna) and the veterinary and wild fauna services of the countries involved.

*Biometric measurements on birds
hunted in Burkina Faso, 2006
François Lamarque, © Cirad*



- Acquisition of equipment and skills for the molecular diagnosis of avian influenza in partnership with AFSSA (French Agency for Food Health Security), funded by the Languedoc-Roussillon region;
- Research grants funded by the French Ministry of Foreign Affairs and the European Union, in collaboration with French, European, African and Asian institutions and scientists, aiming to achieve:
 - a better understanding of epidemiological cycles and the virus flows between bird communities,
 - risk analysis and modeling of the disease spread in time and space,
 - economic and social management of health crises and the risks linked to the reconstruction of the poultry sector.



A researcher preparing a sample in order to identify the H5N1 virus in Burkina Faso, 2006 - François Lamarque, © Cirad

For further information

French scientific organization sites :

<http://www.afssa.fr>

<http://www.invs.sante.fr>

<http://www.pasteur.fr/externe>

<http://www.cirad.fr/fr/presse/>

French veterinary school sites :

<http://www.vet-lyon.fr/webex/ga/>

<http://www.vet-nantes.fr>

<http://www.envt.fr>

<http://www.vet-alfort.fr>

Official French sites :

<http://www.grippeaviaire.gouv.fr>

<http://www.sante.gouv.fr>

http://www.premier-ministre.gouv.fr/thematique/agriculture_m66/

<http://www.agriculture.gouv.fr/spip/>

<http://www.ecologie.gouv.fr/sommaire.php3>

<http://www.cfes.sante.fr>

http://ec.europa.eu/dgs/health_consumer/index_en.htm

Scientific information sites :

<http://www.cite-sciences.fr/english/indexFLASH.htm>

<http://www.oncfs.gouv.fr>

http://www.futura-sciences.com/sinformer/o/grippe_aviare.php/

http://www.rfi.fr/langues/statiques/rfi_anglais.asp

<http://www.itavi.asso.fr>

International resource center sites :

http://www.who.int/csr/disease/avian_influenza/en/index.html

http://www.oie.int/eng/en_index.htm

http://www.fao.org/ag/againfo/subjects/en/health/diseases-cards/special_avian.html

<http://www.wetlands.org>

<http://www.ecdc.eu.int>

<http://www.promedmail.org/pls/promed/>

<http://www.inspq.qc.ca/english/>

http://www.oie.int/eng/OIE/organisation/en_OFFLU.htm

<http://www.livestockworkinggroup.org/>

<http://www.info.gov.hk/info/flu/eng/index.htm>

<http://www.cdc.gov/flu/avian/outbreaks/asia.htm>



Flock of village ducks in Niger, 2006 - Alexandre Caron, © Cirad



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The handbook on bird flu / avian influenza

An initiative of CIRAD (Centre de recherche internationale en recherche agronomique pour le développement / French Agricultural Research Centre for International Development) to provide information on this disease that began as an animal health problem in countries of Southeast Asia in 1997 before reaching Africa in early 2006.

An initiative supported by:

- World Organization for Animal Health (OIE),
- Food and Agriculture Organization of the United Nations (FAO),
- Inter-African Bureau of Animal Resources of the African Union (AU-IBAR),
- Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA),
- French Ministry of Foreign Affairs,
- Agropolis International,
- Technical Aviculture Institute (ITAVI),
- CEVA SANTE ANIMALE,
- National Institute of Agriculture Research (INRA)
- French Agricultural Research Centre for International Development (CIRAD)

This handbook was published to contribute to the diffusion of scientific knowledge among diverse audiences in the North and South and is not intended for sale. Instead, it is to be widely distributed upon simple request to support educational projects and to share scientific learning.

For additional information :



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